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**Calibration of a surround panel
used to measure window and door
U-values in the rotatable hot box
apparatus as specified in
BS EN ISO 12567-1:2000 and
prEN 12567-2**

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May 2003

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Abstract

The measurement procedures in BS EN ISO 12567-1:2000 require that the surround panel used to measure window and door U-values in a hot box apparatus must be calibrated by carrying out hot box measurements on two glazed calibration panels of different thickness, each at three different temperature conditions. This report describes measurements carried out with the NPL Rotatable Wall Guarded Hot Box (RWGHB) following these procedures, using the glazed calibration panels TT206 and TT207, mounted in the 150 mm thick expanded polystyrene surround panel number Rothold2. The results are presented exactly as shown in the standard. Results are also given of a measurement carried out of a 1.48 m high x 1.23 m wide PVCu window system that had been previously measured using a different surround panel calibrated with these glazed calibration panels in the Wall Guarded Hot Box. The difference between the U-values from the two apparatus was 1.8%, which is excellent agreement, being only slightly worse than the measurement repeatability of the two apparatus ($\pm 1.2\%$).

The draft standard prEN 12567-2 sets out measurement procedures for measuring the U-values of Roof windows and projecting windows. That standard also requires measurements to be made of the same glazed calibration panels but mounted in a different position in the surround panel. These calibration measurements have also been carried out with both horizontal and vertical heat flow. The results of those measurements are also included in this report.

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1. GLOSSARY OF SYMBOLS AND UNITS

Symbol	Physical quantity	Unit
A	area	m^2
d	thickness (depth)	m
F	fraction	--
f	view factor	--
h	surface coefficient of heat transfer	$\text{W}/(\text{m}^2 \cdot \text{K})$
L	perimeter length	m
q	density of heat flow rate	W/m^2
R	thermal resistance	$\text{m}^2 \cdot \text{K}/\text{W}$
T	thermodynamic temperature	K
U	thermal transmittance	$\text{W}/(\text{m}^2 \cdot \text{K})$
w	width	m
α	radiant factor	--
$\Delta T, \Delta \theta$	temperature difference	K
ε	total hemispherical emissivity	--
θ	Celsius temperature	$^{\circ}\text{C}$
λ	thermal conductivity	$\text{W}/(\text{m} \cdot \text{K})$
σ	Stefan Boltzmann constant	$\text{W}/(\text{m}^2 \cdot \text{K}^4)$
Φ	heat flow rate	W
ψ	linear thermal transmittance	$\text{W}/(\text{m} \cdot \text{K})$

Subscripts

Subscript	Meaning
b	baffle
c	convection (air)
cal	calibration
e	exterior, usually cold side
i	interior, usually warm side
in	input
m	measured
me	mean
n	environmental (ambient)
ne	environmental (ambient) external
ni	environmental (ambient) internal
p	reveal of surround panel
r	radiation (mean)
s	surface
sp	specimen
st	standardised
sur	surround panel
t	total

2. INTRODUCTION

The calibration procedures specified in BS EN ISO12567-1:Section 6.2 were used to calibrate an expanded polystyrene (EPS) surround panel (Rothold2) using two glazed calibration panels TT206 and TT207. The procedure requires measurements to be made on two different thicknesses of glazed calibration panels, each at three different temperature conditions. The calibration panels comprise a core of EPS sandwiched between two sheets of 4 mm thick float glass. The method of manufacture was that specified in BS EN ISO 12567-1: Annex C1. The thermal conductivity of the EPS was measured in the NPL standard guarded hot plate apparatus and the average thickness of the calibration panels were measured using a special device built for the purpose. From these data the thermal conductance of each calibration panel was determined.

From the data obtained from the hot box measurements on the calibration panels, three graphs were produced. These graphs are used to carry out the following:

- Calculate the density of heat flow rate through the holder panel, including any boundary loss around the reveal.
- Calculate the hot and cold environmental temperatures.
- Correct for the change in surface resistance that results from changing the heat flux density, from the value used to establish the air flow conditions that produced a total surface resistance of $0.17 \text{ (m}^2\cdot\text{K)/W}$ with the thin calibration panel, to the heat flux density used when measuring the window.

3. THE GLAZED CALIBRATION PANELS

The thermal conductivity values of the expanded polystyrene used in the calibration panels were taken from NPL Test Reports PP21/E01090142 and PP21/E01090090. The thermal conductance values are taken from NPL Test Report PP31/E02020284.

4. CALIBRATION MEASUREMENTS CARRIED OUT FOR EN ISO 12567-1

The 21 mm thick glazed calibration panel was installed in surround panel Rothold2 mounted 40 mm from the warm face of the holder panel as specified in BS EN ISO 12567-1. The thermal conductance of this panel was then measured with a warm air temperature of 23.3°C and a cold air temperature of 2.7°C . The air speed in the cold box was adjusted to give a total surface resistance of $0.17 \pm 0.01 \text{ m}^2\cdot\text{K/W}$. The cold box air speed was then kept at this setting for the rest of the calibration measurements and indeed for all subsequent window measurements. The measurement schedule as specified in BS EN ISO 12567-1 was then carried out on the 21 mm and the 58 mm thick glazed calibration panels. The summary results for these six measurements are shown in Tables 1 to 6. The calculation procedures specified in BS EN ISO 12567-1 were then used to produce the data shown in EN 12567-1: Tables D1, D2, D3 and D4. These are shown in Tables 7, 8, 9 and 10. The three graphs required by the standard are shown in Figure 1.

Table 2 Results - Thin panel – Cold air 10°C – Horizontal HF – for EN 12567-1

R02L				Rothold2				Data entered by.....										RGW		Programme		ROT_LOG7.TXT	
Thin Calibration panel				Data entry checked by.....														Hot fan volts		7			
				Service number...														Cold fan setting		48			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Specimen Cold surface	Specimen Hot temp	Air Cold temp	Air Hot temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used	Boundary loss actual								
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(µV)	(W)	(W)								
1.0105																							
2 Dec 2002	06:32:48	1.82488	0.0343		52.6278	23.155	10.2162	20.2502	11.1553	23.7158	22.8185	10.19308	1.9	0	1.18906			Line1					
2 Dec 2002	08:32:49	1.82488	0.0343		52.5782	23.1556	10.2191	20.2522	11.1595	23.7172	22.8179	10.18801	5.4	0	1.19035			Line2					
2 Dec 2002	10:32:50	1.82488	0.0343		52.5375	23.1576	10.1907	20.2663	11.1507	23.7223	22.8349	10.16328	2.8	0	1.19313			Line3					
2 Dec 2002	12:32:50	1.82488	0.0343		52.6467	23.1576	10.2266	20.2541	11.1745	23.7116	22.8152	10.2045	-0.9	0	1.18752			Line4					
2 Dec 2002	14:32:40	1.82488	0.0343		52.6456	23.1882	10.2418	20.2873	11.1807	23.7395	22.8485	10.19924	-0.5	0	1.19136			Line5					
Averages		1.8249	0.03430		52.6072	23.163	10.219	20.262	11.164	23.721	22.827	10.190	1.7	0.000	1.190								

R02L																			
Area of specimen	1.8249	m²	Thick @ edge	21.02	mm	Mean temp	15.71	°C	Hr (c)	5.795									
Area holder	3.963	m²	Holder thickness	0.14967	m	λ Holder	0.03430	W/m.K	Hr (h)	5.177									
Boundary correction	0.000	Watts	Baffle Emis. Hot	0.95		Spec. Emis. Hot	0.9		Emissivity Factor Hot	0.8593									
			Baffle Emis Cold	0.95		Spec. Emis. Cold	0.9		Emissivity Factor Cold	0.8593									

Total power	Surround	Surface	Power	Hot	Cold	Surface	Air temperatures		Environmental temperatures		Baffle temperatures		Thermal		Surface Resistance				
Corfor	Hot	Cold	through	surface	Temp	Temp	Hot	Cold	diff	Hot	Cold	diff	Hot	Cold	Trans	Hot	Cold		
HFV Off	(W)	(°C)	Insert	temp	diff	diff	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(W/m².K)	(W/m².K)	(m².K/W)	(m².K/W)
06:32:48	52.621	23.155	10.216	40.871	20.250	11.155	9.095	23.716	10.048	13.667	23.139	10.073	13.067	22.818	10.193	2.463	1.714	0.129	0.048
08:32:49	52.559	23.156	10.219	40.811	20.252	11.159	9.093	23.717	10.035	13.682	23.139	10.061	13.078	22.818	10.188	2.459	1.710	0.129	0.049
10:32:50	52.527	23.158	10.191	40.752	20.266	11.151	9.116	23.722	10.008	13.714	23.151	10.035	13.116	22.835	10.163	2.450	1.703	0.129	0.050
12:32:50	52.650	23.158	10.227	40.907	20.254	11.174	9.080	23.712	10.062	13.650	23.137	10.086	13.052	22.815	10.205	2.469	1.718	0.129	0.049
14:32:40	52.647	23.188	10.242	40.890	20.287	11.181	9.107	23.739	10.046	13.694	23.169	10.072	13.097	22.848	10.199	2.461	1.711	0.129	0.049
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Av. Values	52.601	23.163	10.219	40.846	20.262	11.164	9.098	23.721	10.040	13.681	23.147	10.065	13.082	22.827	10.190	2.460	1.711	0.129	0.049
Variation	0.23%	0.033	0.051	0.38%	0.037	0.030	0.39%	0.028	0.054	0.47%	0.031	0.051	0.50%	0.033	0.041	0.77%	0.88%	0.001	0.002
Surround temp difference			12.944	°C			Atmospheric pressure			not measured			mb			Calc	2.487		
Surround mean temperature			16.691	°C									Error			-1.1			

Table 3 Results - Thin panel – Cold air –6.5°C - Horizontal HF – for EN 12567-1

R02M				Data entered by.....										RGW		Programme		ROT_LOG7.TXT	
TT 206 In Rothold2				Data entry checked by.....												Hot fan volts		7	
				Service number...												Cold fan setting		48	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Holder Cold temp	Specimen surface	Specimen Hot temp	Specimen Cold temp	Air Hot temp	Air Cold temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used	Boundary loss actual		
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)	(W)		
					1.0105														
4 Dec 2002	15:20:02	1.82488	0.0329		113.3483	22.41	-6.1646	16.2901	-4.12822	23.6234	-6.53412	21.7362	-6.27519	4.3	0	2.624	Line1		
4 Dec 2002	17:20:05	1.82488	0.0329		113.0804	22.3937	-6.14198	16.3191	-4.04341	23.6112	-6.4790861	21.7353	-6.22166	-0.2	0	2.618	Line2		
4 Dec 2002	19:19:59	1.82488	0.0329		113.0856	22.3972	-6.10993	16.2965	-4.0568	23.6219	-6.4765248	21.7272	-6.21571	5.2	0	2.619	Line3		
4 Dec 2002	21:20:02	1.82488	0.03291		112.9465	22.3977	-5.99821	16.3171	-3.9542	23.6159	-6.4408473	21.7326	-6.13565	5.4	0	2.615	Line4		
4 Dec 2002	23:19:58	1.82488	0.0329		112.7680	22.3867	-6.16067	16.3138	-4.05421	23.5991	-6.6569607	21.733	-6.31117	0.7	0	2.632	Line5		
Averages		1.8249	0.03290		113.0458	22.397	-6.115	16.307	-4.047	23.614	-6.518	21.733	-6.232	3.1	0.000	2.621			

R02M										
Area of specimen	1.8249	m²	Thick @ edge	mm		Mean temp	6.13	°C	Hr (c)	5.647
Area holder	3.963	m²	Holder thickness	0.14967		λ Holder	0.03290	W/mK	Hr (h)	4.356
Boundary correction	0.000	Watts	Baffle Emis. Hot	0.95		Emissivity Factor Hot	0.8593		Tot Res	0.1774
			Baffle Emis Cold	0.95		Emissivity Factor Cold	0.8593			

Total		Surround Surface		Power through		Hot surface		Air temperatures		Environmental temperatures		Baffle temperatures		Thermal Surface Resistance						
power	Hot	Cold	surface	Hot	Cold	Temp	Temp	Hot	Cold	diff	Hot	Cold	diff	Hot	Cold					
Corfor	Insert	Temp	Temp	Hot	Cold	diff	diff	Hot	Cold	diff	Hot	Cold	diff	Hot	Cold					
HFMOff	- BL%																			
(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(m².K/W)	(m².K/W)					
15:20:02	113.333	22.410	-6.165	88.442	16.290	-4.128	20.418	23.623	-6.534	30.158	22.438	-6.497	28.955	21.736	-6.275	2.374	1.674	0.127	0.049	
17:20:05	113.081	22.394	-6.142	88.224	16.319	-4.043	20.363	23.611	-6.479	30.090	22.456	-6.442	28.897	21.735	-6.222	2.374	1.673	0.127	0.050	
19:19:59	113.067	22.397	-6.110	88.234	16.297	-4.057	20.353	23.622	-6.477	30.098	22.451	-6.439	28.890	21.727	-6.216	2.376	1.675	0.127	0.049	
21:20:02	112.927	22.398	-5.998	88.191	16.317	-3.954	20.271	23.616	-6.441	30.057	22.455	-6.396	28.851	21.733	-6.136	2.384	1.673	0.127	0.051	
23:19:58	112.765	22.387	-6.161	87.898	16.314	-4.054	20.368	23.599	-6.657	30.256	22.446	-6.604	29.050	21.733	-6.311	2.365	1.658	0.127	0.053	
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Av.Values	113.035	22.397	-6.115	88.198	16.307	-4.047	20.355	23.614	-6.518	30.132	22.453	-6.475	28.929	21.733	-6.232	2.374	1.671	0.127	0.050	
Variation	0.50%	0.023	0.166	0.62%	0.029	0.174	0.72%	0.024	0.216	0.66%	0.012	0.208	0.69%	0.009	0.176	0.81%	1.02%	0.000	0.004	
Surround temp difference	28.512			°C	not measured										mb		Calc		2.391	
Surround mean temperature	8.141			°C											Error		-0.7			

Table 4 Results - Thick panel - Cold air 4°C – Horizontal HF – for EN 12567-1

R03H Rothold2
Calibration Panel TT207

RGW
Data entered by.....
Data entry checked by.....
Service number....

Programme ROT_LOG7.TXT
Hot fan volts 7
Cold fan setting 48

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Holder Cold temp	Specimen surface Hot	Specimen surface Cold	Air temp Hot	Air temp Cold	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used	Boundary loss actual	
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)	(W)	
22-Dec-02	19:41:57	1.82415	0.03373		37.5451	23.0439	3.98186	21.8922	4.23938	23.7207	3.7048839	23.1794	3.825257	3.3	0	0.686	Line1
22-Dec-02	21:41:52	1.82415	0.03373		37.463	23.0476	3.99713	21.898	4.26201	23.7212	3.7277578	23.18	3.853161	-0.1	0	0.686	Line2
22-Dec-02	23:41:58	1.82415	0.03373		37.5865	23.0491	3.97563	21.9041	4.25084	23.7256	3.7184867	23.1861	3.840315	3.7	0	0.686	Line3
23-Dec-02	01:41:52	1.82415	0.03373		37.6208	23.0627	3.99369	21.9154	4.2643	23.7393	3.761958	23.1951	3.856779	2.8	0	0.686	Line4
23-Dec-02	03:41:58	1.82415	0.03373		37.7036	23.0579	3.99992	21.909	4.26688	23.7339	3.7349711	23.1929	3.852067	1.5	0	0.686	Line5
Averages		1.8242	0.03373		37.5838	23.052	3.990	21.904	4.257	23.728	3.730	23.187	3.846	2.2	0.000	0.686	

R03H										
Area of specimen	1.8242	m²	Thick @ edge	57.74	mm	Mean temp	13.08	°C	Hr (c)	5.854
Area holder	3.963	m²	Holder thickness	0.14967	m	λ Holder	0.03373	W/m.K	Hr (h)	4.822
Boundary correction	0.000	Watts	Baffle Emis. Hot	0.95		Emissivity Factor Hot		0.8593	Tot Res	0.1761
			Baffle Emis Cold	0.95		Emissivity Factor Cold		0.8593		

Total	Surround	Surface	Power	Hot	Hot	Surface	Air temperatures	Environmental temperatures	Baffle temperatures	Thermal	Thermal	Surface	Resistance							
power	Hot	Cold	through	surface	surface	Temp	Hot	Cold	diff	Hot	Cold	Cond	Hot							
Corfor			Insert	temp	temp	diff						Trans	Cold							
HEM Off			- BL %																	
(W)	(°C)	(°C)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(W/m².K)	(m².K/W)							
19:41:57	37.533	23.044	3.982	20.506	21.892	4.239	17.653	23.721	3.705	20.016	23.364	3.718	19.647	23.179	3.825	0.637	0.572	0.131	0.046	
21:41:52	37.463	23.048	3.997	20.446	21.898	4.262	17.636	23.721	3.728	19.993	23.365	3.741	19.624	23.180	3.853	0.636	0.571	0.131	0.046	
23:41:58	37.573	23.049	3.976	20.536	21.904	4.251	17.653	23.726	3.718	20.007	23.372	3.731	19.641	23.186	3.840	0.638	0.573	0.130	0.046	
01:41:52	37.611	23.063	3.994	20.577	21.915	4.264	17.651	23.739	3.762	19.977	23.383	3.771	19.612	23.195	3.857	0.639	0.575	0.130	0.044	
03:41:58	37.698	23.058	4.000	20.675	21.909	4.267	17.642	23.734	3.735	19.999	23.381	3.747	19.633	23.193	3.852	0.642	0.577	0.130	0.046	
	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Av. Values	37.576	23.052	3.990	20.548	21.904	4.257	17.647	23.728	3.730	19.999	23.373	3.742	19.631	23.187	3.846	0.638	0.574	0.130	0.046	
Variation	0.62%	0.019	0.024	1.11%	0.023	0.028	0.10%	0.019	0.057	0.19%	0.019	0.054	0.18%	0.016	0.032	1.08%	1.06%	0.001	0.003	
Surround temp difference		19.063	°C			Atmospheric pressure		not measured		mb			Calc		0.657					
Surround mean temperature		13.521	°C										Error		-2.8					

Table 5 Results - Thick panel – Cold air 10°C – Horizontal HF – for EN 12567-1

R03J		Rothold2		Data entered by.....										RGW		Programme		ROT_LOG7.TXT					
TT207 in Rothold2		Data entry checked by....																		Hot fan volts		7	
		Service number...																		Cold fan setting		48	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Holder Cold temp	Specimen surface Hot	Specimen surface Cold	Air Hot temp	Air Cold temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundry loss used	Boundry loss actual							
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)	(W)							
28-Dec-02	03:01:09	1.82415	0.03434		25.3714	23.3031	10.5303	22.5322	10.72207	23.7488	10.354323	23.39	10.4383	-16.5	0	0.41	Line1						
28-Dec-02	05:01:05	1.82415	0.03434		25.3746	23.2839	10.4987	22.5116	10.69211	23.7351	10.3423	23.3728	10.42036	-26.5	0	0.41	Line2						
28-Dec-02	07:01:11	1.82415	0.03434		25.4315	23.3083	10.5129	22.5342	10.72037	23.7587	10.349636	23.3929	10.43352	-21.7	0	0.41	Line3						
28-Dec-02	09:01:06	1.82415	0.03435		25.4018	23.294	10.6098	22.519	10.78452	23.7396	10.426579	23.3802	10.50106	-19.1	0	0.41	Line4						
28-Dec-02	11:01:02	1.82415	0.03435		25.4047	23.2963	10.5835	22.5237	10.76418	23.7412	10.403604	23.3832	10.48533	-22.6	0	0.41	Line5						
Averages		1.8242	0.03434		25.3968	23.297	10.547	22.524	10.737	23.745	10.375	23.384	10.456	-21.3	0.000	0.410							

R03J	Area of specimen	1.8242	m²	Thick @ edge	57.74	mm	Mean temp		16.63		°C	Hr (c)		5.880	
	Area holder	3.963	m²	Holder thickness	0.14967	m	λ Holder		0.03434		W/m.K	Hr (h)		5.172	
	Boundary correction	0.000	Watts	Baffle Emis. Hot	0.95		Spec. Emis. Hot		0.9			Emissivity Factor Hot		0.8593	
				Baffle Emis. Cold	0.95		Spec. Emis. Cold		0.9			Emissivity Factor Cold		0.8593	
											Tot Res		0.1757		

Total		Surround Surface		Power		Hot surface		Air temperatures		Environmental temperatures		Baffle temperatures		Thermal Surface Resistance			
power	Corfor	Hot	Cold	through Insert	Hot surface temp	Hot surface temp	Cold surface temp	Hot	Cold	Hot	Cold	Hot	Cold	Thermal Cond	Surface Resistance		
HFV Off	HFV Off	(°C)	(°C)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(W/m².K)	(m².K/W)		
03:01:09	25.431	23.303	10.530	13.815	22.532	10.722	11.810	23.749	10.354	13.394	23.514	10.364	13.150	23.390	10.438		
05:01:05	25.471	23.284	10.499	13.843	22.512	10.692	11.819	23.735	10.342	13.393	23.497	10.351	13.147	23.373	10.420		
07:01:11	25.510	23.308	10.513	13.873	22.534	10.720	11.814	23.759	10.350	13.409	23.519	10.359	13.160	23.393	10.434		
09:01:06	25.471	23.294	10.610	13.935	22.519	10.785	11.735	23.740	10.427	13.313	23.505	10.435	13.070	23.380	10.501		
11:01:02	25.487	23.296	10.584	13.925	22.524	10.764	11.760	23.741	10.404	13.338	23.508	10.413	13.095	23.383	10.485		
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Av. Values	25.474	23.297	10.547	13.878	22.524	10.737	11.787	23.745	10.375	13.369	23.509	10.384	13.124	23.384	10.456	0.645	0.129
Variation	0.31%	0.024	0.111	0.87%	0.023	0.092	0.092	0.024	0.084	0.72%	0.022	0.084	0.68%	0.020	0.081	1.51%	0.001
Surround temp difference		12.750	°C					Atmospheric pressure	not measured		mb			Calc	0.665		
Surround mean temperature		16.922	°C											Error	-2.9		

Table 6 Results - Thick panel - Cold air -5°C - Horizontal HF - for EN 12567-1

R03K		Rothold2		Data entered by.....										RGW		Programme		ROT_LOG7.TXT	
TT207 in Rothold2		Data entry checked by.....												Hot fan volts		7			
		Service number...												Cold fan setting		48			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
Date	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Holder Cold temp	Specimen surface Hot temp	Specimen surface Cold temp	Air Hot temp	Air Cold temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used	Boundary loss actual				
	(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)	(W)				
2 Jan 2003	00:35:21	1.82415	0.03304	52.9185	22.7199	-4.53773	21.0538	-4.17956	23.6631	-4.954208	22.8688	-4.78622	2.4	0	0.983		Line1		
2 Jan 2003	02:35:25	1.82415	0.03303	52.9415	22.7224	-4.58828	21.0579	-4.20697	23.6674	-4.965126	22.8698	-4.81411	3	0	0.983		Line2		
2 Jan 2003	04:35:23	1.82415	0.03303	53.1316	22.7125	-4.6058	21.0507	-4.22447	23.658	-5.032096	22.8628	-4.85032	0.5	0	0.983		Line3		
2 Jan 2003	06:35:18	1.82415	0.03303	53.0656	22.708	-4.64497	21.0438	-4.27113	23.655	-5.071196	22.86	-4.88918	5.8	0	0.983		Line4		
2 Jan 2003	08:35:16	1.82415	0.03303	53.073	22.6877	-4.57077	21.0281	-4.21251	23.6435	-4.981911	22.8411	-4.82021	3	0	0.983		Line5		
Averages		1.8242	0.03303	53.0260	22.710	-4.590	21.047	-4.219	23.657	-5.001	22.861	-4.832	2.9	0.000	0.983				

R03K																				
Area of specimen	1.8242	m²	Thick@edge	57.74	mm	Mean temp		8.41		°C		Hr (c)		5820						
Area holder	3.963	m²	Holder thickness	0.14967	m	λ Holder		0.03303		W/m.K		Hr (h)		4.391						
Boundary correction	0.000	Watts	Baffle Emis. Hot	0.95		Spec. Emis. Hot		0.9				Emissivity Factor Hot		0.8593						
			Baffle Emis. Cold	0.95		Spec. Emis. Cold		0.9				Emissivity Factor Cold		0.8593						
Total power		Surround	Surface	Power	Hot	Cold	Surface	Air temperatures	Environmental temperatures	Baffle temperatures	Thermal	Thermal	Surface	Resistance						
Corfor	Hot	Hot	Cold	through	surface	surface	Temp	Hot	Cold	diff	Hot	Cold	Hot	Cold	Cond	Trans	Hot	Cold		
HFM Off	Cold	Cold	Insert	Insert	temp	temp	diff	Hot	Cold	diff	Hot	Cold	Hot	Cold	Cond	Trans	Hot	Cold		
(W)	(°C)	(°C)	(W)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(W/m².K)	(W/m².K)	(m².K/W)	(m².K/W)		
00:35:21	52.910	22.720	-4.538	29.067	21.054	-4.180	25.233	23.663	-4.954	28.617	23.142	-4.938	28.080	22.869	0.631	0.567	0.131	0.048		
02:35:25	52.931	22.722	-4.588	29.042	21.058	-4.207	25.265	23.667	-4.965	28.632	23.145	-4.951	28.095	22.870	0.630	0.567	0.131	0.047		
04:35:23	53.130	22.713	-4.606	29.234	21.051	-4.224	25.275	23.658	-5.032	28.690	23.140	-5.014	28.153	22.863	0.634	0.569	0.130	0.049		
06:35:18	53.045	22.708	-4.645	29.119	21.044	-4.271	25.315	23.655	-5.071	28.726	23.134	-5.053	28.187	22.860	0.631	0.566	0.131	0.049		
08:35:16	53.062	22.688	-4.571	29.219	21.028	-4.213	25.241	23.643	-4.982	28.625	23.120	-4.966	28.086	22.841	0.635	0.570	0.131	0.047		
	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Av. Values	53.015	22.710	-4.590	29.136	21.047	-4.219	25.266	23.657	-5.001	28.658	23.136	-4.984	28.120	22.861	0.632	0.568	0.131	0.048		
Variation	0.41%	0.035	0.107	0.66%	0.030	0.092	0.32%	0.024	0.117	0.38%	0.025	0.115	0.38%	0.029	0.103	0.70%	0.001	0.003		
Surround temp difference		27.300	°C	Atmospheric pressure		not measured		mb				Calc	0.647							
Surround mean temperature		9.060	°C									Error	-2.2							

Table 7 - Measured values of TT206 and TT207 –(Table D1 in EN 12567-1)

Measured values			Thin panel TT206			Thick panel TT207		
d	overall thickness	m	0.02102			0.05774		
A	area of panel	m ²	1.8249			1.82415		
S _{sur}	area of surround panel	m ²	3.96272			3.96345		
A _t	hot box metering area	m ²	5.7876			5.7876		
L	perimeter length	m	5.42			5.42		
Test number			2	1	3	5	4	6
Cold temperatures								
θ_{ce}	air	°C	10.04	2.68	-6.52	10.38	3.73	-5.00
$\theta_{se,b}$	baffle	°C	10.19	2.89	-6.23	10.46	3.85	-4.83
$\theta_{se,cal}$	calibration panel	°C	11.16	4.41	-4.05	10.74	4.26	-4.22
$\theta_{se,p}$	reveal surface	°C	10.32	3.11	-5.93	10.53	3.96	-7.34
$\theta_{se,sur}$	surround panel	°C	10.22	2.96	-6.12	10.55	3.99	-4.59
Warm temperatures								
θ_{ci}	air	°C	23.72	23.63	23.61	23.74	23.73	23.6574
$\theta_{si,b}$	baffle	°C	22.83	22.28	21.73	23.38	23.19	22.8605
$\theta_{si,cal}$	calibration panel	°C	20.26	18.43	16.31	22.52	21.90	21.0469
$\theta_{si,p}$	reveal surface	°C	21.75	20.72	19.60	22.91	22.46	21.75
$\theta_{si,sur}$	surround panel	°C	23.16	22.76	22.40	23.30	23.05	22.7101
ϕ_{in}	input power	W	52.60	79.93	113.03	25.47	37.58	53.0154
v_i	air flow warm side (down)	m/s	0.1	0.1	0.1	0.1	0.1	0.1
v_e	air flow cold side (up)	m/s	4.1	4.1	4.1	4.6	4.6	4.6

Table 8 View factor calculations - (Table d2 in EN 12567-1)

Values resulting from mounting instructions			Remarks	Thin panel TT206	Thick panel TT207
Total thickness of the calibration panel	mm		-	21.016	57.738
Total thickness of the surround panel	mm		-	149.67	149.67
Surround panel reveal depth - warm side	mm		-	40	40
Surround panel reveal depth - cold side	mm		-	88.65	51.93
Thermal conductivity of the surround panel	W/(m.K)		E0	0.0336	0.0337
Emissivity of the calibration panel				0.88	0.88
Emissivity of the reveal				0.92	0.92
Emissivity of the baffle				0.95	0.95
Ψ_{edge} for $\lambda = 0.0334$ (W/(m.K))	W/(m.K)		Table B.1	-	0.00636
Warm side	view factors	f_{cbi}	Table A.1	0.944	0.944
		f_{ppi}	Table A.1	0.0472	0.0472
		f_{cpi}	equation (A.11)	0.056	0.056
		f_{bpi}	equation (A.11)	0.056	0.056
	radiant factors	f_{pbi}	equation (A.12)	0.4764	0.4764
		α_{cbi}	equation (A.8)	0.7910	0.7910
		α_{cpi}	equation (A.9)	0.04765	0.04765
Cold side	view factors	f_{cbe}	Table A.1	0.8809	0.92832
		f_{ppe}	Table A.1	0.1043	0.06017
		f_{cpe}	equation (A.11)	0.1191	0.0717
		f_{bpe}	equation (A.11)	0.1191	0.0717
	radiant factors	f_{pbe}	equation (A.12)	0.4478	0.4699
		α_{cbe}	equation (A.8)	0.7400	0.7783
		α_{cpe}	equation (A.9)	0.10149	0.06100

Table 9 Thermal resistance of surround panel – (Table D3 in EN 12567-1)

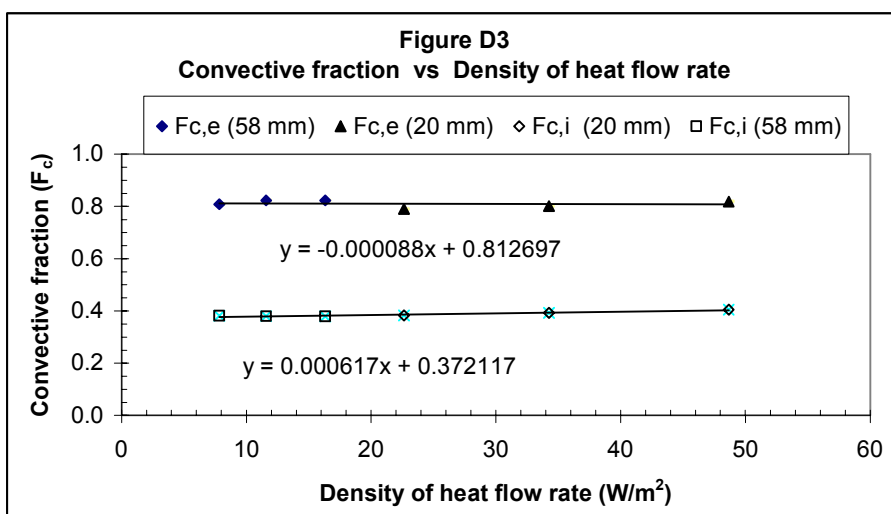
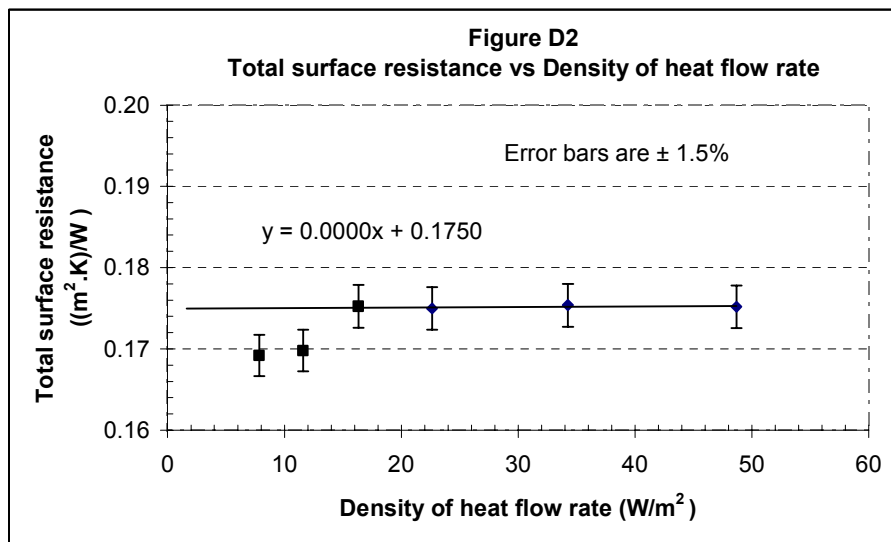
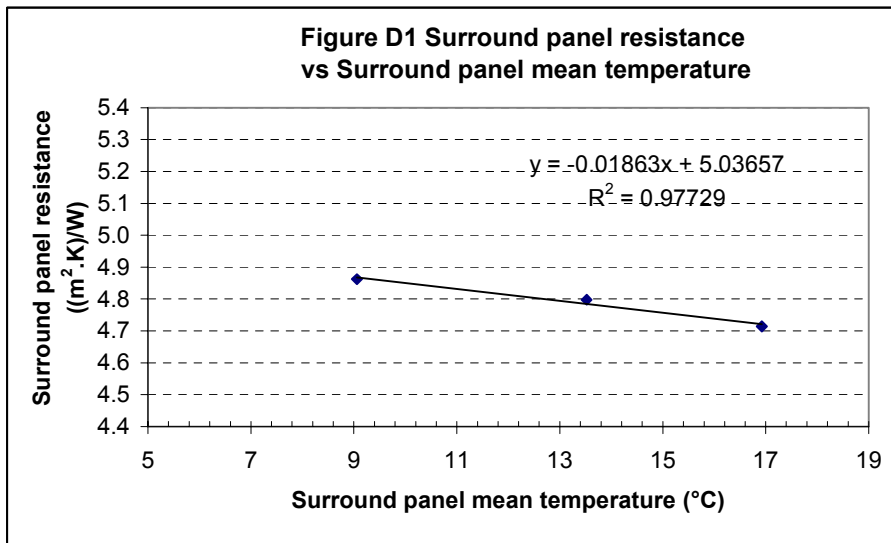
Data element			Remarks	Thick panel TT207		
Temperature difference air	$\Delta\theta_c$	K	-	13.3694	19.9985	28.6583
Temperature difference surface, surround	$\Delta\theta_{s,\text{sur}}$	K	-	12.7501	19.0626	27.2996
Temperature mean surround	$\theta_{\text{me},\text{sur}}$	°C	-	16.92	13.52	9.06
Heat flow rate into the box	Φ_{in}	W	-	25.4741	37.5757	53.0154
Heat flow rate through the calibration panel	Φ_{cal}	W	equation 9	14.2932	21.1381	29.7741
Heat flow rate around perimeter	Φ_{edge}	W	equation 10	0.46086	0.68937	0.98789
Power through surround panel ($\Phi_{\text{in}} - \Phi_{\text{cal}} - \Phi_{\text{edge}}$)	Φ_{sur}	W	-	10.72	15.7482	22.2533
Thermal resistance of the surround panel	R_{sur}	(m ² .K)/W	equation 8	4.71404	4.79759	4.86222
Optional check with thermal conductivity data						
Temperature mean surround	$\theta_{\text{me},\text{sur}}$	°C		16.92	13.52	9.06
thermal conductivity of surround @ $\theta_{\text{me},\text{sur}}$	λ_{sur}	W/(m.K)		0.0343	0.0337	0.0330
Thickness of the holder panel	d_{sur}	m		0.14967	0.14967	0.14967
Thermal resistance of the surround panel	$R_{\text{sur}(\text{check})}$	(m ² .K)/W		4.35804	4.43709	4.53121
Difference in resistance				-8.1687	-8.1249	-7.3051

Table 10 Surface resistance & environmental temperatures – (Table D4 in EN 12567-1)

Data element	Remarks	Thin panel TT206		Thick panel TT207	
Mean temperature cal panel	$\theta_{me,cal}$ °C	15.71	11.42	16.63	8.41
Surface temp diff cal panel	$\Delta\theta_{s,cal}$ K	9.10	14.02	11.78749	25.2658
Thermal resistance cal panel	R_{cal} m ² .K/W	0.4021	0.4092	1.5044	1.5479
Density of heat flow rate thro' cal panel	q_{cal} W/m ²	22.625	34.261	7.8355	16.3222
Warm blackbody radiant heat transfer coefficient baffle	$h_{cb,i}$ W/m ² .K	5.8045	5.7348	5.8881	5.8287
Cold blackbody radiant heat transfer coefficient baffle	$h_{cb,e}$ W/m ² .K	5.1857	4.8100	5.1812	4.3962
Warm blackbody radiant heat transfer coefficient reveal	$h_{cp,i}$ W/m ² .K	5.7726	5.6888	5.8740	5.7957
Cold blackbody radiant heat transfer coefficient reveal	$h_{cp,e}$ W/m ² .K	5.1891	4.8159	5.1833	4.3350
radiant heat transfer coefficient warm side	$h_{r,i}$ W/m ² .K	4.8663	4.8071	4.9372	4.8865
radiant heat transfer coefficient cold side	$h_{r,e}$ W/m ² .K	4.3640	4.0481	4.3489	3.6862
Mean radiant temperature warm side	$\theta_{r,i}$ °C	22.77	22.19	23.36	22.80
Mean radiant temperature cold side	$\theta_{r,e}$ °C	10.20	2.92	10.46	-5.01
Warm side convective heat transfer coefficient	$h_{c,i}$ W/m ² .K	3.018	3.111	3.051	2.976
Cold side convective heat transfer coefficient	$h_{c,e}$ W/m ² .K	16.400	16.324	18.368	17.122
Warm side convective fraction	$F_{c,i}$ -	0.3828	0.3929	0.3819	0.3785
Cold side convective fraction	$F_{c,e}$ -	0.7898	0.8013	0.8086	0.8229
Warm side environmental temperature	$\theta_{hi,cal}$ °C	23.13	22.76	23.51	23.12
Cold side environmental temperature	$\theta_{ne,cal}$ °C	10.07	2.73	10.39	-5.00
Environmental temperature difference	$\Delta\theta_{hi,cal}$ K	13.06	20.03	13.11	28.13
Warm side surface resistance	$R_{s,i}$ (m ² .K)/W	0.1268	0.1263	0.1252	0.1272
Cold side surface resistance	$R_{s,e}$ (m ² .K)/W	0.0482	0.0491	0.0440	0.0481
Total surface resistance	$R_{s,t}$ (m ² .K)/W	0.1750	0.1754	0.1692	0.1752

Stefan-Boltzmann constant	5.670E-08 W/m ² .K ⁴
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Figure 1 Surround panel resistance, convective fractions and total surface resistance



5. CALIBRATION MEASUREMENTS AS SPECIFIED IN prEN 12567-2

To enable measurements to be carried out as specified in prEN 12567-2 “Thermal performance of windows and doors – Determination of thermal transmittance by hot box method – Part 2: Roof windows and other projecting windows”, further calibration measurements have to be carried out. The results from the thick glazed calibration panel TT207 can be used to derive the surround panel thermal resistance (R_{sur}) but additional measurements are required with the thin calibration panel mounted flush with the cold face of the surround panel. From these measurements, the convective fractions will be derived. No correction is made to compensate for the changing total surface resistance value in the part 2 procedures.

The 21 mm thick glazed calibration panel was installed in surround panel Rothold2 mounted flush with the cold face of the surround panel as specified in prEN 12567-2. The thermal conductance of this panel was then measured with a warm air temperature of about 23°C and a cold air temperature of about 3°C. The air speed in the cold box was adjusted to give a total surface resistance of $0.17 \pm 0.01 \text{ m}^2\text{.K/W}$. The cold box air speed was then kept at this setting for the rest of the calibration measurements and indeed for all subsequent window measurements to prEN 12567-2. The measurement schedule as specified in prEN 12567-2 was then carried out on the 21 mm thick glazed calibration panel. These measurements were first carried out with horizontal heat flow and then repeated with vertically up heat flow.

The summary results for the three new measurements on the thin panel, with horizontal heat flow, can be seen in Table 11, Table 12 and Table 13. The calculation procedures specified in prEN 12567-2 were used to produce the data shown in Tables C1, C2, C3 and C4 of prEN 12567-2. These tables are shown in Table 17, Table 18, Table 19 and Table 20 of this report. The two graphs that are required to determine the U-values of roof windows as specified in prEN 12567-2, using horizontal heat flow, are shown in Figure 2.

The summary results for the other three new measurements on the thin panel, with vertically up heat flow, can be seen in Table 14, Table 15 and Table 16. The calculation procedures specified in prEN 12567-2 were then used to produce the data shown in Tables C1, C2, C3 and C4 of prEN 12567-2. These tables are shown in Table 21, Table 22, Table 23 and Table 24 of this report. The two graphs that are required to determine the U-values of roof windows, as specified in prEN 12567-2, using vertically up heat flow, are shown in Figure 3.

Table 11 Results - Thin panel - Horizontal HF – Cold air 3 °C- for prEN 12567-2

R08A				Data entered by.....										RGW		Programme		ROT_LOG8.TXT	
TT206 - Flush mount - Vertical mount				Data entry checked by.....												Hot fan volts		7	
				Service number...												Cold fan setting		48	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18			
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Holder Cold temp	Specimen surface Hot temp	Specimen surface Cold temp	Air Hot temp	Air Cold temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used				
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)				
10-Feb-03	5:55	1.82594	0.03366	0.03309	80.0635	22.897	3.26379	18.483	4.57446	23.601	2.9429607	22.365	3.122828	3.2	1.797		Line1		
10-Feb-03	7:55	1.82594	0.03365	0.03309	80.1475	22.882	3.24936	18.4721	4.58133	23.591	2.9210986	22.350	3.111391	5.6	1.790		Line2		
10-Feb-03	9:55	1.82594	0.03365	0.03309	79.9668	22.877	3.24979	18.4716	4.58505	23.588	2.9416638	22.340	3.125482	6	1.798		Line3		
10-Feb-03	11:55	1.82594	0.03365	0.03309	80.0692	22.887	3.23773	18.4671	4.56587	23.587	2.9230075	22.351	3.107672	3.2	1.796		Line4		
10-Feb-03	13:55	1.82594	0.03365	0.03309	79.9805	22.882	3.24527	18.4727	4.59164	23.582	2.9238048	22.351	3.119216	3.3	1.798		Line5		
Averages		1.8259	0.03366		80.0455	22.885	3.249	18.473	4.580	23.590	2.931	22.351	3.117	4.3	1.796				

R08A																	
Area of specimen		1.8259	m²	Thick @ edge		21.02	mm	Mean temp		11.53		°C	Hr (c)		5.730		
Area holder		3.962	m²	Holder thickness		0.14967	m	λ Holder		0.03366		W/m.K	Hr (h)		4.812		
Boundary correction		1.796	Watts	Baffle Emis. Hot		0.95		Spec. Emis. Hot		0.9		Emissivity Factor Hot		0.8593			
				Baffle Emis. Cold		0.95		Spec. Emis. Cold		0.9		Emissivity Factor Cold		0.8593			

Table 12 Results - Thin panel - Horizontal HF – Cold air 10°C - for prEN 12567-2

R08B		Data entered by.....										RGW		Programme		ROT_LOG7.TXT	
TT206 - Flush mount - Vertical mount		Data entry checked by.....												Hot fan volts		7	
		Service number...												Cold fan setting		48	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Specimen surface Hot temp	Specimen surface Cold temp	Air Hot temp	Air Cold temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used			
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)			
13-Feb-03	3:03	1.82594	0.03431		53.0629	23.220	20.312	20.250	11.200	23.693	22.849	10.252	2.6	1.180			Line1
13-Feb-03	5:04	1.82594	0.03431		53.1549	23.203	20.259	20.226	11.142	23.672	22.839	10.202	-0.4	1.181			Line2
13-Feb-03	7:04	1.82594	0.03431		53.0686	23.197	20.264	20.234	11.160	23.671	22.835	10.201	3.2	1.182			Line3
13-Feb-03	9:03	1.82594	0.03431		52.9841	23.205	20.272	20.242	11.174	23.670	22.841	10.215	1.9	1.182			Line4
13-Feb-03	11:04	1.82594	0.03431		52.9796	23.189	20.322	20.229	11.208	23.665	22.831	10.263	6.4	1.176			Line5
Averages		1.8259	0.03431		53.0500	23.203	20.286	20.236	11.177	22.839	22.839	10.227	2.7	1.180			

R08B																	
Area of specimen	1.8259	m²	Thick @ edge	21.02	mm	Mean temp		15.71		°C		Hr (c)		5.796			
Area holder	3.962	m²	Holder thickness	0.14967	m	λ Holder		0.03431		W/m.K		Hr (h)		5.180			
Boundary correction	1.180	Watts	Baffle Emis. Hot	0.95		Spec. Emis. Hot		0.9		Emissivity Factor Hot		Tot Res		0.1792			
			Baffle Emis. Cold	0.95		Spec. Emis. Cold		0.9		Emissivity Factor Cold							

Total power	Surround	Surface	Power	Hot	Cold	Surface	Air	temperatures	Environmental	temperatures	Baffle	temperatures	Thermal	Surface	Resistance		
Corfor	Hot	Cold	through	temp	surface	Temp	Hot	Cold	diff	Hot	Cold	diff	Cond	Trans	Hot		
HFV Off	(W)	(°C)	Insert	temp	temp	diff	Hot	Cold	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)		
			- BL %	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)		
03:03:59	53.053	23.220	10.312	40.151	20.250	9.050	23.693	10.131	13.562	23.140	10.151	12.990	10.252	2.430	1.693	0.131	0.048
05:04:01	53.156	23.203	10.259	40.220	20.226	11.142	23.672	10.098	13.574	23.126	10.114	13.011	22.839	10.202	2.425	1.693	0.132
07:04:02	53.057	23.197	10.264	40.130	20.234	11.160	23.671	10.088	13.583	23.124	10.107	13.017	22.835	10.201	2.422	1.688	0.131
09:03:00	52.977	23.205	10.272	40.050	20.242	11.174	23.670	10.090	13.580	23.127	10.111	13.017	22.841	10.215	2.419	1.685	0.132
11:04:01	52.956	23.189	10.322	40.096	20.229	11.208	23.665	10.148	13.517	23.118	10.167	12.951	22.831	10.263	2.434	1.695	0.132
	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Av.Values	53.040	23.203	10.286	40.130	20.236	11.177	9.059	23.674	10.111	13.563	23.127	12.997	22.839	10.227	2.426	1.691	0.132
Variation	0.38%	0.031	0.063	0.42%	0.024	0.067	0.71%	0.028	0.060	0.49%	0.022	0.060	0.018	0.062	0.64%	0.62%	0.002
Surround temp difference			12.917	°C			Atmospheric pressure	not measured		mb			Calc	2.487			
Surround mean temperature			16.744	°C									Error	-2.5			

name	ROT_LOG7.TXT
volts	7
n setting	48

17	18
	Line1
	Line2
	Line3
	Line4
	Line5

Hr (c)	5.668
Hr (h)	4.476
Tot Res	0.1765

Thermal Surface Resistance		
Trans	Hot	Cold
(W/m ² K)/(m ² K/W) (m ² K/W)		
1.667	0.128	0.048
1.672	0.128	0.048
1.672	0.128	0.048
1.669	0.128	0.048
1.664	0.129	0.048
*	*	*
1.669	0.128	0.048
0.46%	0.001	0.000

Table 14 Results - Thin panel - Vertically up HF – Cold air 3 °C - for prEN 12567-2

R09A		Data entered by.....										RGW		Programme		ROT_LOG8.TXT	
TT206 Mounted flush & vertically up heat-flow		Data entry checked by.....												Hot fan volts		7	
		Service number...												Cold fan setting		48	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18	
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Holder Cold temp	Specimen Hot surface	Specimen Cold surface	Air temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss			
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)			
"28/02/2003 07:42:18		1.8259	0.0337	0.0	84.670	23.5039	2.937	18.892	4.392	24.111	22.884	2.807	0.70	1.870		Line1	
"28/02/2003 10:03:05		1.8259	0.0337	0.0	84.794	23.4814	2.984	18.882	4.415	24.084	22.865	2.881	5.30	1.859		Line2	
"28/02/2003 12:03:09		1.8259	0.0337	0.0	84.678	23.4913	3.029	18.883	4.462	24.109	22.873	2.915	-0.30	1.860		Line3	
"28/02/2003 14:03:12		1.8259	0.0337	0.0	84.459	23.4598	2.990	18.867	4.443	24.068	22.846	2.883	-0.20	1.860		Line4	
"28/02/2003 16:03:05		1.8259	0.0337	0.0	84.980	23.488	3.002	18.874	4.433	24.101	22.870	2.890	2.00	1.861		Line5	
Averages		1.8259	0.03368		84.7160	23.485	2.989	18.880	4.429	24.095	22.868	2.875	1.5	1.862			

R09A																				
Area of specimen	1.8259	m²	Thick @ edge	21.02	mm				Mean temp	11.65	°C	Hr (c)	5.757							
Area holder	3.962	m²	Holder thickness	0.14967	m				λ Holder	0.03368	W/m.K	Hr (h)	4.800							
Boundary correction	1.862	Watts	Baffle Emis. Hot	0.95		Spec. Emis. Hot	0.9		Emissivity Factor	Hot	0.8593	Tot Res	0.1741							
			Baffle Emis. Cold	0.95		Spec. Emis. Cold	0.9		Emissivity Factor	Cold	0.8593									
Total power	Surround power	Surround area	Surface Hot	Surface Cold	Surface Temp	Air temperatures	Environmental temperatures	Baffle temperatures	Thermal	Thermal	Thermal	Thermal	Thermal	Thermal	Surface Resistance	Surface Resistance	Surface Resistance			
Corfor	Hot	Hot	through surface	Hot surface	Cold surface	Hot	Cold	diff	Hot	Cold	diff	Hot	Cold	Hot	Hot	Cold	Cold			
HEM Off	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(W/m².K)	(m².K/W)	(m².K/W)			
00:00:00	84.667	23.504	2.937	64.460	18.892	24.111	2.617	21.494	23.345	2.646	20.699	22.884	2.807	2.435	1.706	0.126	0.049			
00:00:00	84.775	23.481	2.984	64.641	18.882	24.084	2.715	21.369	23.327	2.740	20.587	22.865	2.881	2.447	1.720	0.126	0.047			
00:00:00	84.679	23.491	3.029	64.575	18.883	24.421	2.732	21.377	23.339	2.760	20.579	22.873	2.915	2.452	1.719	0.126	0.048			
00:00:00	84.459	23.460	2.990	64.350	18.867	24.424	2.692	21.376	23.306	2.722	20.585	22.846	2.883	2.443	1.712	0.126	0.049			
00:00:00	84.972	23.488	3.002	64.847	18.874	24.433	2.715	21.386	23.336	2.741	20.595	22.870	2.890	2.459	1.724	0.126	0.048			
	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
Av.Values	84.711	23.485	2.989	64.575	18.880	4.429	14.451	24.095	2.694	21.400	23.331	2.722	20.609	2.875	2.447	1.716	0.126			
Variation	0.61 %	0.044	0.092	0.77 %	0.025	0.070	0.54 %	0.043	0.116	0.59 %	0.039	0.114	0.58 %	0.108	1.00 %	1.10 %	0.002			
Surround temp difference		20.496	°C			Atmospheric pressure	not measured	mb						Calc	2.447					
Surround mean temperature		13.237	°C											Error	0.0					

Table 15 Results - Thin panel - Vertically up HF – Cold air 10 °C - for prEN 12567-2

R09B		Data entered by.....										RGW		Programme		ROT_LOG8.TXT	
TT206 Mounted flush & vertically up heat-flow		Data entry checked by.....												Hot fan volts		7	
		Service number...												Cold fan setting		48	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Date	time	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder Hot temp	Holder Cold temp	Specimen surface Hot	Specimen surface Cold	Air temp Hot	Air temp Cold	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used		
		(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)		
" 3 Mar 2003 14:09:33		1.8259	0.0343	0.0	56.056	23.701	10.181	20.579	11.153	24.127	9.999	23.285	10.129	0.10	1.229		Line1
"3 Mar 2003 12:09:32		1.8259	0.0343	0.0	56.176	23.708	10.158	20.585	11.123	24.129	9.985	23.293	10.108	-0.20	1.231		Line2
"3 Mar 2003 10:09:32		1.8259	0.0343	0.0	55.972	23.724	10.154	20.598	11.120	24.140	9.963	23.309	10.092	-0.30	1.233		Line3
" 3 Mar 2003 08:09:32		1.8259	0.0344	0.0	56.040	23.758	10.217	20.633	11.171	24.174	9.994	23.334	10.128	-1.20	1.234		Line4
" 3 Mar 2003 06:09:41		1.8259	0.0344	0.0	56.356	23.790	10.169	20.636	11.151	24.202	9.987	23.369	10.121	1.70	1.237		Line5
Averages		1.8259	0.03435		56.1202	23.736	10.176	20.606	11.143	24.154	9.986	23.318	10.116	0.0	1.233		

R09B																							
Area of specimen	1.8259	m²	Thick @ edge	21.02	mm							Mean temp	15.87	°C	Hr (c)	5.818							
Area holder	3.962	m²	Holder thickness	0.14967	m							λ Holder	0.03435	W/m.K	Hr (h)	5.175							
Boundary correction	1.233	Watts	Baffle Emis. Hot	0.95		Spec. Emis. Hot		0.9				Emissivity Factor Hot			Tot Res	0.1778							
			Baffle Emis Cold	0.95		Spec. Emis. Cold		0.9				Emissivity Factor Cold											
Total	Surround	Surface	Power	Hot	Hot	Surface	Air temperatures	Environmental temperatures	Baffle temperatures	Thermal	Thermal	Surface Resistance											
power	Hot	Cold	through	surface	surface	Temp	Hot	Cold	diff	Hot	Cold	Hot	Cold	Hot	Cold	Trans	Hot	Cold					
Corfor			Insert	temp	temp	diff																	
HFM Off			- BL %																				
(W)	(°C)	(°C)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(W/m².K)	(W/m².K)	(m².K/W)					
00:00:00	56.056	23.701	10.181	42.534	20.579	11.153	9.426	24.127	9.999	14.128	23.584	10.020	13.564	23.285	10.129	2.471	1.717	0.129	0.049				
00:00:00	56.176	23.708	10.158	42.626	20.585	11.123	9.462	24.129	9.985	14.144	23.591	10.005	13.586	23.293	10.108	2.467	1.718	0.129	0.048				
00:00:00	55.973	23.724	10.154	42.401	20.598	11.120	9.478	24.140	9.963	14.177	23.602	9.984	13.618	23.309	10.092	2.450	1.705	0.129	0.049				
00:00:00	56.045	23.758	10.217	42.499	20.633	11.171	9.462	24.174	9.994	14.180	23.633	10.017	13.616	23.334	10.128	2.460	1.709	0.129	0.050				
00:00:00	56.350	23.790	10.169	42.729	20.636	11.151	9.486	24.202	9.987	14.215	23.663	10.009	13.654	23.369	10.121	2.467	1.714	0.129	0.049				
	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
Av. Values	56.120	23.736	10.176	42.558	20.606	11.143	9.463	24.154	9.986	14.169	23.614	10.007	13.607	23.318	10.116	2.463	1.713	0.129	0.049				
Variation	0.67%	0.089	0.063	0.77%	0.057	0.051	0.63%	0.075	0.036	0.61%	0.079	0.036	0.66%	0.084	0.036	0.86%	0.76%	0.001	0.002				
Surround temp difference		13.560	°C			Atmospheric pressure		not measured		mb						Calc	2.489						
Surround mean temperature		16.956	°C													Error	-1.0						

Table 16 Results - Thin panel - Vertically up HF – Cold air -4 °C - for prEN 12567-2

R09C				Rothold2				Data entered by.....										RGW		Programme		ROT_LOG7.TXT									
TT206 Mounted flush & vertically up heat-flow																		Data entry checked by.....										Hot fan volts		7	
																		Service number...										Cold fan setting		48	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18															
Date	Specimen area	Holder Th Cond.	Atm. pressure	Total power	Holder temp	Holder Cold temp	Specimen surface	Specimen Cold surface	Air temp	Air Cold temp	Baffle Hot temp	Baffle Cold temp	Diviny Offset	Boundary loss used																	
	(m²)	(W/m.K)	(mb)	(W)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(uV)	(W)																	
6 Mar 2003	8.44	1.82594	0.0331	110.741	23.251	-3.807	17.294	-1.940	24.027	-4.248	22.435	-4.012	-0.6	2.460			Line1														
6 Mar 2003	6.44	1.82594	0.0331	110.762	23.252	-3.792	17.303	-1.876	24.023	-4.215	22.445	-3.966	0	2.457			Line2														
6 Mar 2003	4.44	1.82594	0.0331	111.099	23.253	-3.851	17.297	-1.950	24.009	-4.272	22.441	-4.043	4.7	2.460			Line3														
6 Mar 2003	2.44	1.82594	0.0331	110.727	23.258	-3.820	17.291	-1.933	24.014	-4.211	22.435	-4.005	5.3	2.456			Line4														
6 Mar 2003	0.44	1.82594	0.0331	110.942	23.249	-3.813	17.287	-1.920	23.997	-4.216	22.433	-3.985	4.5	2.455			Line5														
Averages	1.8259	0.03313		110.8545	23.252	-3.817	17.295	-1.924	24.014	-4.233	22.438	-4.002	2.8	2.457																	

R09C																			
Area of specimen	1.8259	m²	Thick @ edge	21.02	mm	Mean temp		7.69		°C		Hr (c)		5.697					
Area holder	3.962	m²	Holder thickness	0.14967	m	λ Holder		0.03313		W/m.K		Hr (h)		4.465					
Boundary correction	2.457	Watts	Baffle Emis. Hot	0.95		Spec. Emis. Hot		0.9		Emissivity Factor Hot		Tot Res		0.1733					
			Baffle Emis Cold	0.95		Spec. Emis. Cold		0.9		Emissivity Factor Cold									

Total power					Surround Surface					Power					Baffle temperatures				
Confor					Hot					Hot surface					Environmental temperatures				
HFH Off					Cold					Cold surface					Air temperatures				
					Temp diff					Temp diff					diff				

Table 17 prEN 12567-2 Table C1 - Horizontal heat flow

prEN 12567-2 Roof light and Projecting Windows calibration - Horizontal heat flow								
Measured values			Thin panel TT206 Horizontal heat flow			Thick panel TT207 Horizontal heat flow		
d	overall thickness	m	0.02102			0.05774		
A	area of panel	m ²	1.8259			1.82415		
S _{sur}	area of surround panel	m ²	3.96166			3.96345		
A _t	hot box metering area	m ²	5.7876			5.7876		
L	perimeter length	m	5.42			5.42		
Test number			2	1	3	5	4	6
Cold temperatures								
θ _{ce}	air	°C	10.11	2.93	-3.97	10.38	3.73	-5.00
θ _{se,b}	baffle	°C	10.23	3.12	-3.74	10.46	3.85	-4.83
θ _{se,cal}	calibration panel	°C	11.18	4.58	-1.82	10.74	4.26	-4.22
θ _{se,p}	reveal surface	°C	10.29	3.25	-3.35	10.53	3.96	-7.34
θ _{se,sur}	surround panel	°C	10.29	3.25	-3.53	10.55	3.99	-4.59
Warm temperatures								
θ _{ci}	air	°C	23.67	23.59	23.48	23.74	23.73	23.6574
θ _{si,b}	baffle	°C	22.84	22.35	21.87	23.38	23.19	22.8605
θ _{si,cal}	calibration panel	°C	20.24	18.47	16.82	22.52	21.90	21.0469
θ _{si,p}	reveal surface	°C	20.99	21.15	20.19	22.91	22.46	21.75
θ _{si,sur}	surround panel	°C	23.20	22.89	22.56	23.30	23.05	22.7101
ϕ _{in}	input power	W	53.04	80.03	105.73	25.47	37.58	53.0154
v _i	air flow warm side (down)	m/s	0.1	0.1	0.1	0.1	0.1	0.1
v _e	air flow cold side (up)	m/s	4.1	4.1	4.1	4.6	4.6	4.6

Table 18 prEN 12567-2 Table C2 - Horizontal heat flow

prEN 12567-2 Roof light and Projecting Windows calibration - Horizontal heat flow					
Values resulting from mounting instructions			Remarks	Thin panel TT206 Horizontal heat flow	Thick panel TT207 - Results from EN 12567-1 calibration measurements
Total thickness of the calibration panel		mm	-	21.016	57.738
Total thickness of the surround panel		mm	-	149.67	149.67
Surround panel reveal depth - warm side		mm	-	128.65	40
Surround panel reveal depth - cold side		mm	-	0.00	51.93
Thermal conductivity of the surround panel		W/(m.K)	E0	0.0337	0.0337
Emissivity of the calibration panel				0.88	0.88
Emissivity of the reveal				0.92	0.92
Emissivity of the baffle				0.95	0.95
Ψ_{edge} for $\lambda = 0.0334$ (W/(m.K)		W/(m.K)		-	0.00636
Warm side	view factors	f_{cbi}	Table A1	0.8338	0.944
		f_{ppi}	Table A1	0.12535	0.0472
		f_{cpi}	equation (A.11)	0.1662	0.056
	radiant factors	f_{bpi}	equation (A.11)	0.1662	0.056
		f_{pbi}	equation (A.12)	0.4373	0.4764
		α_{cbi}	equation (A.8)	0.7019	0.7910
		α_{cpi}	equation (A.9)	0.1415	0.04765
Cold side	view factors	f_{cbe}	Table A.1	1.0000	0.92757
		f_{ppe}	Table A.1	0.0000	0.06070
		f_{cpe}	equation (A.11)	0.0000	0.0724
	radiant factors	f_{bpe}	equation (A.11)	0.0000	0.0724
		f_{pbe}	equation (A.12)	0.5000	0.4697
		α_{cbe}	equation (A.8)	0.8360	0.7777
		α_{cpe}	equation (A.9)	0.00000	0.06165

Table 19 prEN 12567-2 Table C3 - Horizontal heat flow

prEN 12567-2 Roof light and Projecting Windows calibration - Horizontal heat flow						
Data element			Remarks	Thick panel TT207 - Results from EN 12567-1 calibration measurements		
Temperature difference air	$\Delta\theta_c$	K	-	13.36937	19.9985	28.6583
Temperature difference surface, surround	$\Delta\theta_{s,sur}$	K	-	12.75009	19.0626	27.2996
Temperature mean surround	$\theta_{me,sur}$	°C	-	16.92	13.52	9.06
Heat flow rate into the box	Φ_{in}	W	-	25.47405	37.5757	53.0154
Heat flow rate through the calibration panel	Φ_{cal}	W	equation 9	14.29322	21.1381	29.7741
Heat flow rate around perimeter	Φ_{edge}	W	equation 10	0.460858	0.68937	0.98789
Power through surround panel ($\Phi_{in} - \Phi_{cal} - \Phi_{edge}$)	Φ_{sur}	W	-	10.71997	15.7482	22.2533
Thermal resistance of the surround panel	R_{sur}	(m ² .K)/W	equation 8	4.714037	4.79759	4.86222
Optional check with thermal conductivity data						
Temperature mean surround	$\theta_{me,sur}$	°C		16.92	13.52	9.06
thermal conductivity of surround @ $\theta_{me,sur}$	λ_{sur}	W/(m.K)		0.0343	0.0337	0.0330
Thickness of the holder panel	d_{sur}	m		0.14967	0.14967	0.14967
Thermal resistance of the surround panel	$R_{sur(check)}$	(m ² .K)/W		4.358043	4.43709	4.53121
Difference in resistance				-8.16867	-8.1249	-7.3051

Table 20 prEN 12567-2 Table C4 - Horizontal heat flow

prEN 12567-2 Roof light and Projecting Windows calibration - Horizontal heat flow									
Data element	Remarks	Thin panel TT206 Horizontal heat flow			Thick panel TT207 - Results from EN 12567-1 calibration measurements				
Mean temperature cal panel	$\theta_{me,cal}$ °C	15.71	11.53	7.50	16.63	13.08	8.41		
Surface temp diff cal panel	$\Delta\theta_{s,cal}$ K	9.06	13.89	18.63	11.78749	17.6471	25.26579		
Thermal resistance cal panel	R_{cal} m ² .K/W	0.4021	0.4090	0.4159	1.5044	1.5229	1.5479		
Density of heat flow rate thro' cal panel	q_{cal} W/m ²	22.529	33.969	44.810	7.8355	11.5879	16.3222		
Warm blackbody radiant heat transfer coefficient baffle	$h_{cb,i}$ W/m ² .K	5.8041	5.7380	5.6757	5.8881	5.8638	5.8287		
Cold blackbody radiant heat transfer coefficient baffle	h_{cbe} W/m ² .K	5.1870	4.8203	4.4825	5.1812	4.8309	4.3962		
Warm blackbody radiant heat transfer coefficient reveal	$h_{cp,i}$ W/m ² .K	5.7496	5.7027	5.6266	5.8740	5.8421	5.7957		
Cold blackbody radiant heat transfer coefficient reveal	h_{cpe} W/m ² .K	5.1887	4.8238	4.4922	5.1833	4.8340	4.3350		
radiant heat transfer coefficient warm side	$h_{r,i}$ W/m ² .K	4.8877	4.8346	4.7802	4.9372	4.9164	4.8865		
radiant heat transfer coefficient cold side	h_{re} W/m ² .K	4.3364	4.0298	3.7473	4.3491	4.0551	3.6863		
Mean radiant temperature warm side	$\theta_{r,i}$ °C	22.53	22.15	21.59	23.36	23.15	22.80		
Mean radiant temperature cold side	θ_{re} °C	10.23	3.12	-3.74	10.46	3.85	-5.02		
Warm side convective heat transfer coefficient	$h_{c,i}$ W/m ² .K	3.293	3.166	3.302	3.051	3.006	2.976		
Cold side convective heat transfer coefficient	h_{ce} W/m ² .K	17.277	17.025	17.439	18.369	18.889	17.113		
Warm side convective fraction	$F_{c,i}$ -	0.4025	0.3957	0.4086	0.3819	0.3794	0.3785		
Cold side convective fraction	F_{ce} -	0.7994	0.8086	0.8231	0.8086	0.8233	0.8228		
Warm side environmental temperature	$\theta_{ni,cal}$ °C	22.99	22.72	22.36	23.51	23.37	23.12		
Cold side environmental temperature	$\theta_{ne,cal}$ °C	10.13	2.97	-3.93	10.39	3.75	-5.00		
Environmental temperature difference	$\Delta\theta_{n,cal}$ K	12.86	19.75	26.29	13.11	19.61	28.13		
Warm side surface resistance	$R_{s,i}$ (m ² .K)/W	0.1222	0.1250	0.1237	0.1252	0.1262	0.1272		
Cold side surface resistance	R_{se} (m ² .K)/W	0.0463	0.0475	0.0472	0.0440	0.0436	0.0481		
Total surface resistance	$R_{s,t}$ (m ² .K)/W	0.1685	0.1725	0.1709	0.1692	0.1698	0.1753		

Stefan-Boltzmann constant	5.670E-08 W/m ² .K ⁴
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Figure 2 prEN 12567-2 Graphs C1 and C2 - Horizontal heat flow

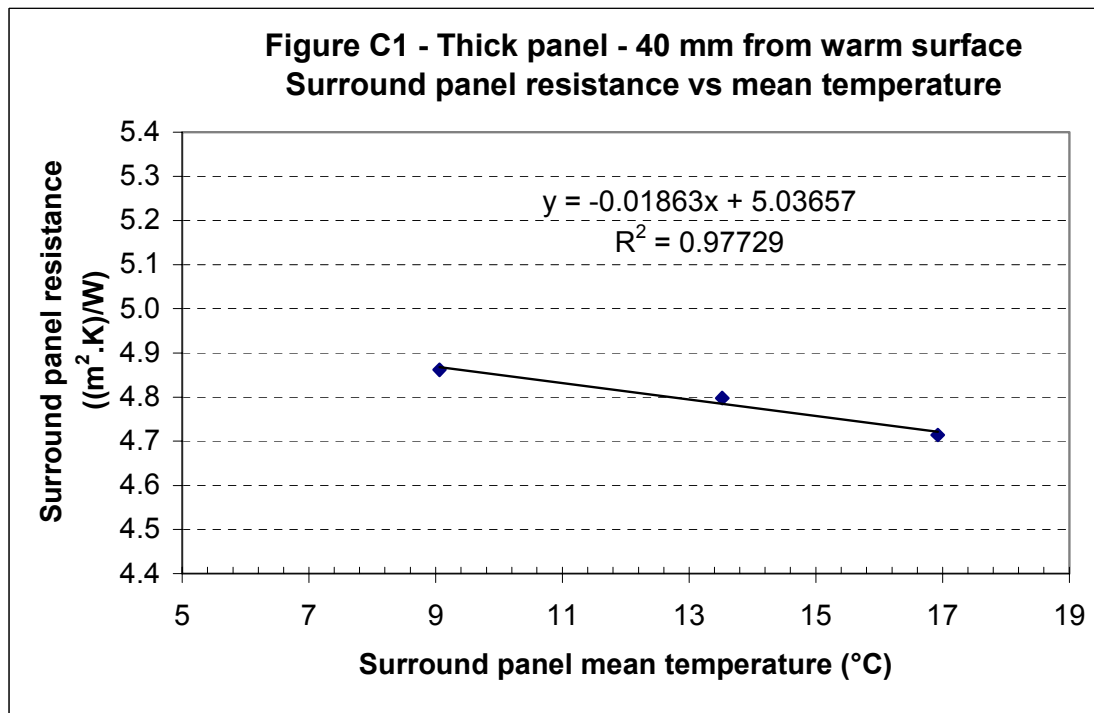
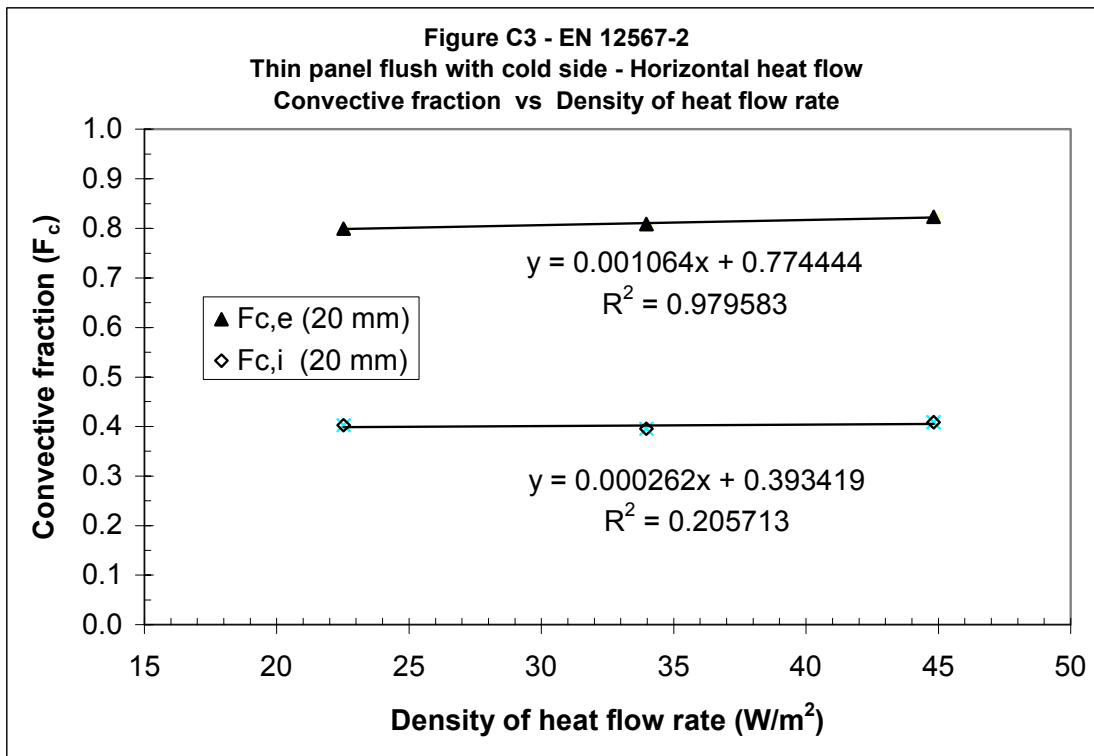


Table 21 prEN 12567-2 - Table C1 - Vertically up heat flow

prEN 12567-2 Roof light and Projecting Windows calibration - Vertical up heat flow								
Measured values			Thin panel TT206			Thick panel TT207		
d	overall thickness	m	0.02102			0.05774		
A	area of panel	m ²	1.8259			1.82415		
S _{sur}	area of surround panel	m ²	3.96166			3.96345		
A _t	hot box metering area	m ²	5.7876			5.7876		
L	perimeter length	m	5.42			5.42		
Test number			2	1	3	5	4	6
Cold temperatures								
θ _{ce}	air	°C	9.99	2.69	-4.23	10.38	3.73	-5.00
θ _{se,b}	baffle	°C	10.12	2.88	-4.00	10.46	3.85	-4.83
θ _{se,cal}	calibration panel	°C	11.14	4.43	-1.92	10.74	4.26	-4.22
θ _{se,p}	reveal surface	°C	10.18	2.99	-3.82	10.53	3.96	-7.34
θ _{se,sur}	surround panel	°C	10.18	2.99	-3.82	10.55	3.99	-4.59
Warm temperatures								
θ _{ci}	air	°C	24.15	24.09	24.01	23.74	23.73	23.6574
θ _{si,b}	baffle	°C	23.32	22.87	22.44	23.38	23.19	22.8605
θ _{si,cal}	calibration panel	°C	20.61	18.88	17.29	22.52	21.90	21.0469
θ _{si,p}	reveal surface	°C	22.44	21.57	20.76	22.91	22.46	21.75
θ _{si,sur}	surround panel	°C	23.74	23.48	23.25	23.30	23.05	22.7101
ϕ _{in}	input power	W	56.12	84.71	110.84	25.47	37.58	53.0154
v _i	air flow warm side (down)	m/s	0.1	0.1	0.1	0.1	0.1	0.1
v _e	air flow cold side (up)	m/s	4.1	4.1	4.1	4.6	4.6	4.6

Table 22 prEN 12567-2 - Table C2 - Vertically up heat flow

prEN 12567-2 Roof light and Projecting Windows calibration - Vertical up heat flow						
Values resulting from mounting instructions			Remarks	Thin panel TT206	Thick panel TT207	
Total thickness of the calibration panel			mm	-	21.016	57.738
Total thickness of the surround panel			mm	-	149.67	149.67
Surround panel reveal depth - warm side			mm	-	128.654	40
Surround panel reveal depth - cold side			mm	-	0.00	51.93
Thermal conductivity of the surround panel			W/(m.K)	E0	0.0337	0.0337
Emissivity of the calibration panel					0.88	0.88
Emissivity of the reveal					0.92	0.92
Emissivity of the baffle					0.95	0.95
Ψ_{edge} for $\lambda = 0.0334$ (W/(m.K))			W/(m.K)	Table B.1	-	0.00636
Warm side	view factors	f_{cbi}	Table A.1	0.8338	0.1253	0.944
		f_{ppi}	Table A.1			0.0472
		f_{cpi}	equation (A.11)			0.056
		f_{bpi}	equation (A.11)	0.16623	0.056	
	radiant factors	f_{pbi}	equation (A.12)	0.43733	0.4764	
		α_{cbi}	equation (A.8)	0.7019	0.7910	
		α_{cpi}	equation (A.9)	0.14154	0.04765	
		Cold side	view factors	f_{cbe}	Table A.1	1.0000
f_{ppe}	Table A.1			0.0000	0.06070	
f_{cpe}	equation (A.11)			0.0000	0.0724	
f_{bpe}	equation (A.11)			0.0000	0.0724	
radiant factors	f_{pbe}		equation (A.12)	0.5000	0.4697	
	α_{cbe}		equation (A.8)	0.8360	0.7777	
	α_{cpe}		equation (A.9)	0.00000	0.06165	

Table 23 prEN 12567-2 - Table C3 - Vertically up heat flow

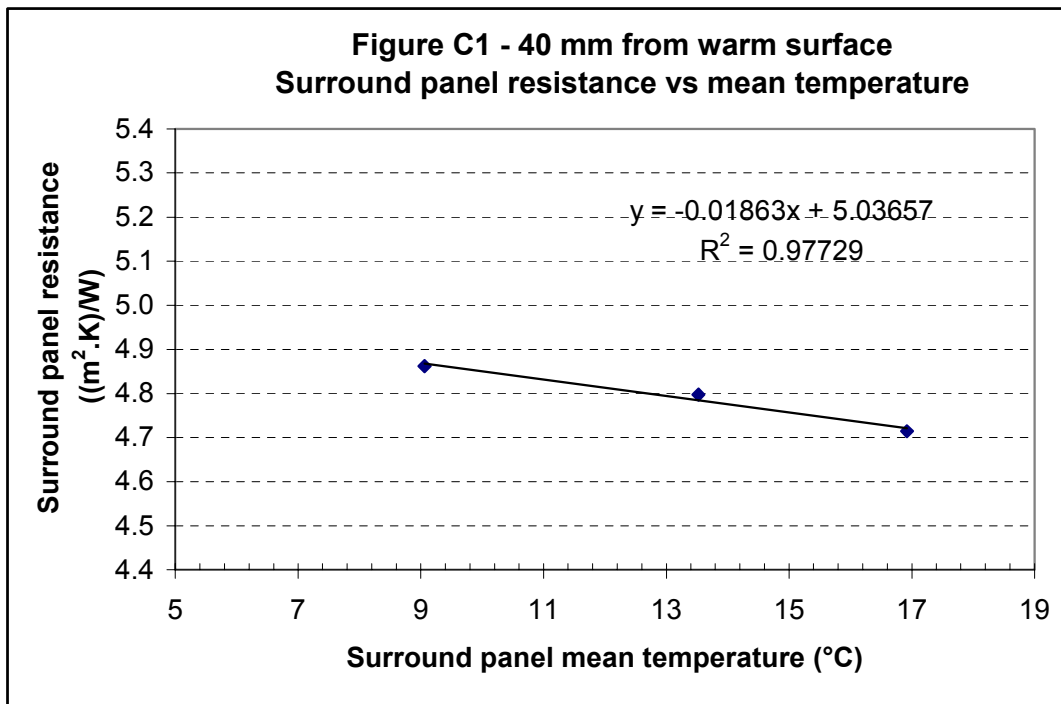
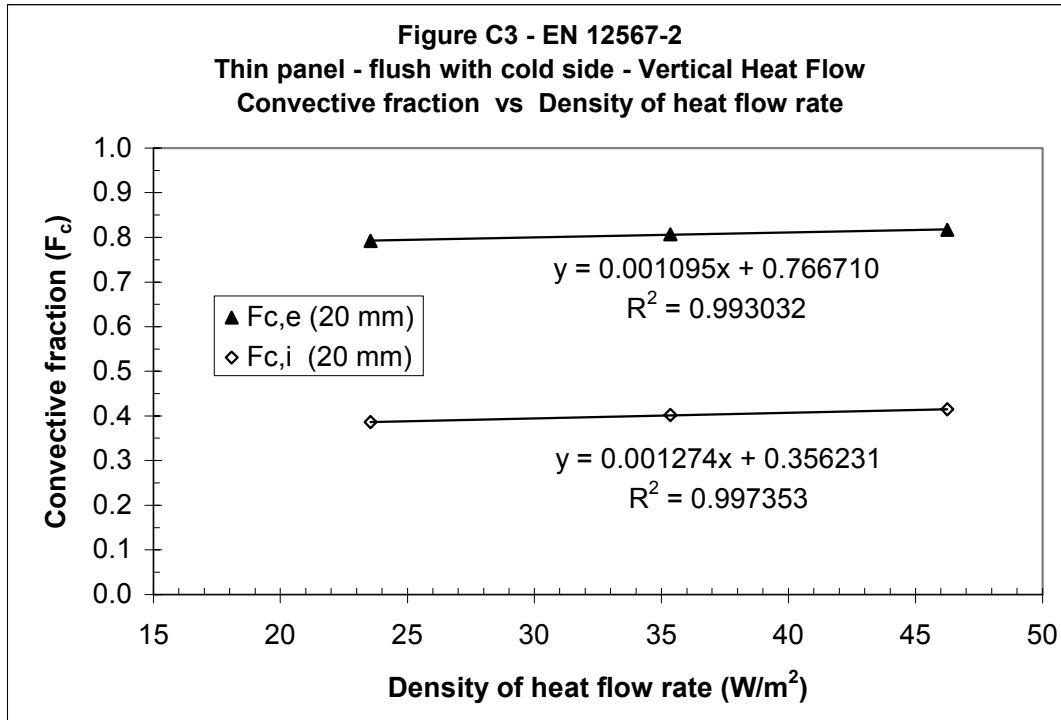
prEN 12567-2 Roof light and Projecting Windows calibration - Vertical up heat flow						
Data element			Remarks	Thick panel TT207		
Temperature difference air	$\Delta\theta_c$	K	-	13.3694	19.9985	28.6583
Temperature difference surface, surround	$\Delta\theta_{s,sur}$	K	-	12.7501	19.0626	27.2996
Temperature mean surround	$\theta_{me,sur}$	°C	-	16.92	13.52	9.06
Heat flow rate into the box	Φ_{in}	W	-	25.4741	37.5757	53.0154
Heat flow rate through the calibration panel	Φ_{cal}	W	equation 9	14.2932	21.1381	29.7741
Heat flow rate around perimeter	Φ_{edge}	W	equation 10	0.46086	0.68937	0.98789
Power through surround panel ($\Phi_{in} - \Phi_{cal} - \Phi_{edge}$)	Φ_{sur}	W	-	10.72	15.7482	22.2533
Thermal resistance of the surround panel	R_{sur}	(m ² .K)/W	equation 8	4.71404	4.79759	4.86222
Optional check with thermal conductivity data						
Temperature mean surround	$\theta_{me,sur}$	°C		16.92	13.52	9.06
thermal conductivity of surround @ $\theta_{me,sur}$	λ_{sur}	W/(m.K)		0.0343	0.0337	0.0330
Thickness of the holder panel	d_{sur}	m		0.14967	0.14967	0.14967
Thermal resistance of the surround panel	$R_{sur(check)}$	(m ² .K)/W		4.35804	4.43709	4.53121
Difference in resistance				-8.1687	-8.1249	-7.3051

Table 24 prEN 12567-2 - Table C4 - Vertically up heat flow

prEN 12567-2 Roof light and Projecting Windows calibration - Vertical up heat flow						
Data element		Remarks	Thin panel TT206		Thick panel TT207	
Mean temperature cal panel	$\theta_{me,cal}$ °C		15.87	11.65	7.69	16.63
Surface temp diff cal panel	$\Delta\theta_{s,cal}$ K		9.46	14.45	19.22	11.78749
Thermal resistance cal panel	R_{cal} m ² .KW	equation 3	0.4019	0.4088	0.4155	1.5044
Density of heat flow rate thro' cal panel	q_{cal} W/m ²	equation 2	23.548	35.350	46.250	7.8355
Warm blackbody radiant heat transfer coefficient baffle	$h_{cb,i}$ W/m ² .K	equation A.6	5.8293	5.7651	5.7063	5.8881
Cold blackbody radiant heat transfer coefficient baffle	$h_{cb,e}$ W/m ² .K	equation A.6	5.1831	4.8101	4.4734	5.1812
Warm blackbody radiant heat transfer coefficient reveal	$h_{cp,i}$ W/m ² .K	equation A.7	5.8032	5.7270	5.6572	5.8740
Cold blackbody radiant heat transfer coefficient reveal	$h_{cp,e}$ W/m ² .K	equation A.7	5.1847	4.8131	4.4781	5.1833
radiant heat transfer coefficient warm side	$h_{r,i}$ W/m ² .K	equation A.5	4.9129	4.8571	4.8059	4.9372
radiant heat transfer coefficient cold side	$h_{r,e}$ W/m ² .K	equation A.5	4.3331	4.0213	3.7398	4.3491
Mean radiant temperature warm side	$\theta_{r,i}$ °C	equation A.3	23.17	22.65	22.16	23.36
Mean radiant temperature cold side	$\theta_{r,e}$ °C	equation A.2	10.12	2.88	-4.00	10.46
Warm side convective heat transfer coefficient	$h_{c,i}$ W/m ² .K	equation A.10	3.086	3.267	3.405	3.051
Cold side convective heat transfer coefficient	$h_{c,e}$ W/m ² .K	equation A.10	16.491	16.774	16.667	18.369
Warm side convective fraction	$F_{c,i}$ -	equation 6	0.3858	0.4021	0.4147	0.3819
Cold side convective fraction	$F_{c,e}$ -	equation 6	0.7919	0.8066	0.8167	0.8086
Warm side environmental temperature	$\theta_{ni,cal}$ °C	equation 7	23.55	23.23	22.93	23.51
Cold side environmental temperature	$\theta_{ne,cal}$ °C	equation 7	10.01	2.73	-4.19	10.39
Environmental temperature difference	$\Delta\theta_{n,cal}$ K	-	13.54	20.50	27.12	13.11
Warm side surface resistance	$R_{s,i}$ (m ² .K)/W	equation 4	0.1250	0.1231	0.1218	0.1252
Cold side surface resistance	$R_{s,e}$ (m ² .K)/W	equation 5	0.0480	0.0481	0.0490	0.0440
Total surface resistance	$R_{s,t}$ (m ² .K)/W	equation 1	0.1730	0.1712	0.1708	0.1692

Stefan-Boltzmann constant	5.670E-08 W/m ² .K ⁴
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Figure 3 prEN 12567-2 Graphs C1 and C2 - Vertically up heat flow



6. CHECK MEASUREMENT CARRIED OUT ON A PVCU WINDOW

A 1.48 m x 1.23 m PVCu window previously measured in the WGHB using the surround panel number 10, calibrated using the same calibration panels (NPL Report CBTLM 18) was re-measured in the Rotatable hot box using surround panel Rothold2 and the calibration data shown in Figure 1. The results can be seen in Table 25, Table 26, Table 27 and Table 28. The results obtained using the WGHB and surround panel 10 can be seen in Table 29 and Table 30. The results from the two sets of measurements are summarized in Table 31.

To determine the U-value from the measurement data following the procedures specified in BS 874: Section 3; Part 3.1, a boundary loss correction has to be applied. The value used was that calculated from the linear thermal transmittance values given in BS EN ISO 12567-1:2000 Table B2.

Table 26 Measured data R05 – (Tables D5 and D6 in EN 12567-1)

Table D5 Window Data			
frame width	w	m	70.00
surround panel thickness	d_{sur}	m	0.14967
area of window	A_{sp}	m^2	1.82708
area of surround panel	A_{sur}	m^2	3.94072
perimeter length	L	m	5.41234

Table D6 Window measurement results			
Cold temperatures			
air	θ_{ce}	$^{\circ}\text{C}$	2.93
baffle	$\theta_{\text{se,b}}$	$^{\circ}\text{C}$	3.12
reveal surface	$\theta_{\text{se,p}}$	$^{\circ}\text{C}$	3.33
surround panel	$\theta_{\text{se,sur}}$	$^{\circ}\text{C}$	3.17
Warm temperatures			
air	θ_{ci}	$^{\circ}\text{C}$	23.73
baffle	$\theta_{\text{si,b}}$	$^{\circ}\text{C}$	22.36
surround panel	$\theta_{\text{si,sur}}$	$^{\circ}\text{C}$	22.75
input power	ϕ_{in}	W	79.31
air flow warm side (down)	v_{i}	m/s	0.1
air flow cold side (up)	v_{e}	m/s	1.6

Table 27 Calculated properties R05 (Table D7 in EN 12567-1)

Table D7 Calculation of the thermal transmittance of window R05				Remarks
Temperature mean surround panel	$\theta_{me,sur}$	°C	12.959	-
Thermal resistance of the surround panel	R_{sur}	(m ² .K)/W	4.7952	Figure D1 / regression
Thermal conductivity of surround @ $\theta_{me,sur}$	λ_{sur}	W/(m.K)	0.0336	-
Ψ_{edge} for w (mm) = 70.0	Ψ_{edge}	W/(m.K)	0.00943	Table B2
Temperature difference surface, surround	$\Delta\theta_{s,sur}$	K	19.575	-
Temperature difference air	$\Delta\theta_c$	K	20.792	
Input power to hot box	ϕ_{in}	W	79.305	
Power through surround panel	Φ_{sur}	W	16.087	equation 12
Edge zone heat flow	Φ_{edge}	W	1.0612	equation 10
Heat flow density through specimen	q_{sp}	W/m ²	34.0198	equation 11
Warm side convective fraction	$F_{c,i}$	-	0.3931	Figure D3 / regression
Cold side convective fraction	$F_{c,e}$	-	0.8097	Figure D3 / regression
Total surface resistance	$R_{s,t}$	(m ² .K)/W	0.1752	Figure D2 / regression
Mean radiant temperature warm side	$\theta_{r,i}$	°C	22.36	equation A.2
Mean radiant temperature cold side	$\theta_{r,e}$	°C	3.14	equation A.2
Warm side environmental temperature	θ_{ni}	°C	22.899	equation 7
Cold side environmental temperature	θ_{ne}	°C	2.973	equation 7
Environmental temperature difference	$\Delta\theta_{n,cal}$	K	19.926	
Environmental temperature mean	$\theta_{n,cal}$	°C	12.936	
U-value measured	U_m	W/(m ² .K)	1.707	equation 13
Uncertainty	ΔU_m	W/(m ² .K)	0.15	
Standard total surface resistance	$R_{s,t}$	(m ² .K)/W	0.17	
Standardized U-value	U_{st}	W/(m².K)	1.723	equation 14

EQUATION COEFFICIENTS FROM THE CALIBRATION MEASUREMENTS ON GLAZED CAL PANELS TT206 & TT207

LINKED TO EXCEL WORKBOOK "ROT EN 1256-1 cal Dec 02 - 2nd run.xls"

Warm side convective fraction	$F_{c,i} =$	0.0006175	X	q_{cal}	+	0.372117
Cold side convective fraction	$F_{c,e} =$	-0.000088	X	q_{cal}	+	0.812697

Total surface resistance of cal panel at this q_{cal}	$R_{s,t} =$	0.00000	X	q_{cal}	+	0.175127
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Thermal resistance of surround panel	$R_{sur} =$	-0.0186279	X	$\theta_{me,sur}$	+	5.036573
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Table 28 Summary of measurement data for R05 (was TT252) in Rotatable hot box

R05		
uPVC		
4 mm toughened/20/6.4 mm laminated Argon filled units with I-Plus on surface 3		
Window dimensions		
Height	1.477	m
Width	1.229	m
Thickness	70.0	mm
Percentage of the window area that is frame	29.2	%
Measured values		
Mean warm air temperature	23.73	°C
Mean warm baffle temperature	22.36	°C
Mean cold air temperature	2.93	°C
Mean cold baffle temperature	3.12	°C
Mean cold reveal temperature	3.33	°C
Power to hot box	79.305	W
Air flow rate in the cold box	4.6	m/s
Air flow rate in the hot box	<0.2	m/s
Calculated values		
Heat flux density through window*	34.020	W/m ² ·K
Warm side convective fraction*	0.393	
Cold side convective fraction*	0.810	
Warm side environmental temperature*	22.90	°C
Cold side environmental temperature*	2.97	°C
Environmental temperature difference	19.93	°C
Environmental temperature mean	12.94	°C
Measured thermal transmittance (U)	1.71	W/m ² ·K
Total surface resistance *	0.175	m ² ·K/W
Thermal transmittance (U) standardised ^[2]	1.72	W/m²·K

{*} Values obtained using graphs produced from measurements on the calibration panels.

Apparatus	Wall Guarded Hot Box
TT252	Holder panel number 10
UPVC Window + double glazed IGU	

[illegible]

Table 30 Summary data for TT252 (Wall Guarded Hot Box – Holder panel 10)

TT252		
UPVC Window		
4/17.6/6.4 Argon filled units with I-Plus coating		
Window dimensions		
Height	1.4770	m
Width	1.2292	m
Thickness	70.0	mm
Percentage of the window area that is frame	29.2	%
Measured values		
Mean warm air temperature	23.44	°C
Mean warm baffle temperature	22.16	°C
Mean cold air temperature	2.80	°C
Mean cold baffle temperature	2.86	°C
Mean cold reveal temperature	3.34	°C
Power to hot box	73.189	W
Air flow rate in the cold box	1.6	m/s
Air flow rate in the hot box	<0.2	m/s
Calculated values		
Heat flux density through window*	34.429	W/m ² ·K
Warm side convective fraction*	0.438	
Cold side convective fraction*	0.760	
Warm side environmental temperature*	22.72	°C
Cold side environmental temperature*	2.83	°C
Environmental temperature difference	19.89	°C
Environmental temperature mean	12.77	°C
Measured thermal transmittance (U)	1.73	W/m ² ·K
Total surface resistance *	0.178	m ² ·K/W
Thermal transmittance (U) standardised ^[2]	1.75	W/m²·K

{*} Values obtained using graphs produced from measurements on the calibration panels.

Table 31 Comparison of UPVC window U-values measured with the different apparatus

Holder panel	Apparatus	Standardised CEN U-value W/m ² .K	As measured “BS 874” U-value W/m ² .K
Holder 10	WGHB	1.754	1.742
Rothold2	Rotatable Hot Box	1.723	1.672

The difference between the standardised CEN U-values measured in the Rotatable hot box and the wall guarded hot box, using the procedures specified in BS EN ISO 12567-1:2000 is 1.8%. The difference between the U-values measured in the Rotatable hot box and the wall guarded hot box, using the procedure specified in BS 874 Section 3; Part 3.1 Annex A is 4.0%.

Note

The basic “BS 874” method is as follows:

- i) the power through the holder panel is calculated from the thermal conductivity of the EPS used to make it, the surface temperature difference across it and its area.
- ii) The environmental temperatures are calculated from the air, surface and baffle temperatures; the surface emissivities; the power through the specimen and the area.
- iii) A correction for the heat transfer around the reveal (boundary loss) is also made.

7. CONCLUSIONS

The difference between U-values measured in the WGHB using holder panel 10 and in the Rotatable Hot Box using holder panel Rothold2, using the procedures specified in EN 12567-1 was 1.8% and therefore the measured values are well within the measurement uncertainty of both apparatus. This agreement is only slightly poorer than the measurement repeatability of the two apparatus.

The equations derived from the calibration measurements made as specified in BS EN ISO 12567-1:2000 and prEN 12567-2 are summarised in Table 32. These will be used to derive the U-values of windows, doors, roof windows and projecting windows when measured mounted in the surround panel Rothold2.

Table 32 Summary of coefficients determined from all measurements

Coefficients for equations derived from measurements carried out with glazed calibration panels TT206 and TT207, mounted in surround panel Rothold2, in the Rotable Hot Box.					
EN 12567-1 - Horizontal heat flow					
Cold convective fraction	$h_{c,e}$		$-0.000087 \times$	q_{cal}	$+ 0.812668243$
Warm convective fraction	$h_{c,i}$		$0.0006175 \times$	q_{cal}	$+ 0.372117301$
Total surface resistance	$R_{s,t}$	$(m^2.K)/W$	$0 \times$	q_{cal}	$+ 0.175146744$
Surround panel resistance	R_{sur}	$(m^2.K)/W$	$-0.0186279 \times$	$q_{me,sur}$	$+ 5.036573485$
prEN 12567-2 - Horizontal heat flow					
Cold convective fraction	$h_{c,e}$		$0.001064 \times$	q_{cal}	$+ 0.774444$
Warm convective fraction	$h_{c,i}$		$0.000262 \times$	q_{cal}	$+ 0.393419$
Total surface resistance	$R_{s,t}$	$(m^2.K)/W$	$0.000111 \times$	q_{cal}	$+ 0.166892$
Surround panel resistance	R_{sur}	$(m^2.K)/W$	$-0.018628 \times$	$q_{me,sur}$	$+ 5.036573$
prEN 12567-2 - Vertical up heat flow					
Cold convective fraction	$h_{c,e}$		$0.001095 \times$	q_{cal}	$+ 0.766710$
Warm convective fraction	$h_{c,i}$		$0.001274 \times$	q_{cal}	$+ 0.356231$
Total surface resistance	$R_{s,t}$	$(m^2.K)/W$	$-0.000100 \times$	q_{cal}	$+ 0.175164$
Surround panel resistance	R_{sur}	$(m^2.K)/W$	$-0.018628 \times$	$q_{me,sur}$	$+ 5.036573$